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Soviet Electric Mine Locomotives

Rudnichnaya Elektrovoznaya Tyaga

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SOVIET ELECTRIC MINE LOCOMOTIVES

[All photographs and drawings referred to in this extract appear in source document.]

The increase in the use of electric locomotives in Soviet mines may be seen in the following table, which shows the development of mechanization in percentages for the various phases of underground coal mining since 1928.

	Percentage of Mechanization, by Years					
Process	1928	1932	1937	1940	1945	1949
Cutting	16.5	62.6	89.6	94.8	92.2	99.0
Conveying from face	--	72.8	84.4	90.4	82.5	99.5
Hauling	--	19.7	47.6	75.2	87.3	93.0
Percentage of hauling performed by electric locomotives	--	8.0	29.7	66.9	77.5	87.0

During the war, production of electric mine locomotives was established in the Urals, and electric locomotives were broadly introduced in the eastern coal fields. In the Kuzbass, mechanized hauling reached 51 percent of the total in 1940, and 87 percent in 1945; in the Karaganda mines it was 37 percent of the total in 1940 and 80 percent in 1945.

The number of electric mine locomotives in coal mining and ore mining areas has increased considerably. In 1931, the entire mining industry had only about 150 electric mine locomotives at its disposal, while in 1940 the coal industry alone was using 1,855 electric locomotives, of which 1,009 were of the storage battery type, and 846 of

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the contact type. On 1 January 1946, despite the ruin inflicted during the war, there were 1,748 electric mine locomotives in the coal industry: 251 were storage battery, 1,497 contact machines. The present overall number of electric mine locomotives in the mining industry is several times greater than the prewar total.

Direct-Current Contact Electric Locomotives

The first contact electric locomotives were the 1-ETR-1, and the 3-ETR-1. After various modifications, they were designated the 1-ETR-2 and 3-ETR-2 respectively. The ETR type locomotives had certain shortcomings, and a new series of contact locomotives was developed, embracing a wide assortment suitable for the most varied hauling conditions. Within this series, all types of locomotives are divided into five sizes having corresponding weights of 3.5, 7, 10, 14, and 18 tons.

During the war, the Aleksandrovskiy Machine Building Plant began series production of the Yu-10 locomotives, which were built according to the plans of A. I. Yushchenko.

The following table gives specifications of the contact hauling locomotives which are now in series production.

	II-TR-2	Yu-10-600	
	II-TR-3	Yu-10-900	IV-TR-4
Gauge (mm)	550-600 and 750-900	600 and 750-900	900
Length (mm)	4,070	4,260	4,810
Width (mm)	1,044 and 1,344	1,070 and 1,370	1,320
Height (mm)	1,500	1,450	1,500
Number of driving axles	2	2	2
Wheel Base (mm)	1,100	1,100	1,650

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	II-TR-2 II-TR-3	Yu-10-600 Yu-10-900	IV-TR-4
Minimum turning circle, radius (m)	7	7	10
Wheel diameter (mm)	650	650	760
Gear ratio	6.92	6.92	6.08
Total weight (t)	6.5 ^{and} 7	10	14
Power, hourly rating (kw)	41.2	41.2	92
Specific power (kw/t)	6.3	4.12	9.26 9.56
Tractive force, hourly rating (kg)	1,460	1,460	2,680
Traction coefficient	0.225/0.208	0.146	0.19
Speed, hourly rating (km/hr)	10.3	10.3	12.4
Tractive force, continuous rating (kg)	370	370	650
Speed, continuous rating (km/hr)	16	16	19
Number of traction motors	2	2	2
Type of motors	DK-801A	DK-801A	DK-802A
Voltage	250	250	250
Amperage, hourly rating	95	95	210
Amperage, continuous rating	34	34	84

A new standard for electric mine locomotives, GOST 5048-49, provides for a change in the designating system of locomotive types. Contact electric mine locomotives will bear the designating letters KR; a number preceding these letters will give the rated weight, while the numbers following the letters will indicate the gauge. Thus the II-TR-2 locomotive becomes the 7KR-600, the II-TR-3 becomes the 7KR-900, and so forth.

The new standard also provides for some changes in the dimensions of the locomotives. In particular, the clearance between the rail-head and the transmission gear will be increased from 36 to 50 millimeters for the 7- and 10-ton locomotives. In conformity with the new standard it has been proposed that a new traction motor be produced for the 10-ton contact type electric locomotive.

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[A photograph of the Yu-10-900 locomotive, showing the bolted sheet metal body, appears on page 163; a drawing of the Yu-10-900 on page 183 numbers various units as follows: 1. motor, 2. controller, 2. power resistor, 4. automatic switch, 5. lighting resistor, 6. pantograph, 7. lighting switch, 8. socket, 9. light 10. bell, 11. sand box, 12. braking system, 13. operator's seat.

A photograph of the II-TR-2g appears on page 182; a drawing of it faces the page.

A drawing of the IV-TR-4 locomotive appears on page 189.]

Condenser Type Alternating-Current Locomotives

The first condenser type [capacitor motor] electric mine locomotive was built in 1943 under the direction of S. A. Volotkovskiy and the chief mechanic of the Yegorshinugol' Trust, Engineer Dionis'yev. It operated for about one year in a mine of the Yegorshinugol' Trust. In 1946, a condenser type electric mine locomotive was designed and built according to specifications of the Ministry of the Coal Industry, by the Moscow Power Institute imeni Molotov, in collaboration with the Moscow Dinamo Plant imeni Kirov. After it had been tested in the Donbass, a series of condenser type locomotives were built. In 1949, the Stalin Prize was awarded Professor V. E. Rozenfel'd, Academician V. S. Kulebakin, Engineer O. A. Nekrasov, and others, for developing and putting into industrial application a new condenser type electric mine locomotives.

The KE-1 condenser type electric mine locomotive is built around the mechanical part of the II-TR-2 locomotive and powered by two MAK-51-6/12 squirrel-cage motors.

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Specifications, KE-1:

Weight (t)	6.5	
Gauge (mm)	600	
Hourly ratings:	Number of Poles	
	<u>2p=12</u>	<u>2p=6</u>
Power (kw)	9.5	19
Voltage	385	380
Amperage	26	36
Power coefficient	0.76	0.88
Motor rpm	422	910
Tractive force (kg)	1,480	1,370
Speed (km/hr)	4.72	10.2
Continuous ratings:		
Power (kw)	6.5	15.0
Voltage	380	380
Amperage	17	27.5
Motor rpm	454	934
Tractive force (kg)	950	1,050
Speed (km/hr)	5.07	10.5

Storage-Battery Electric Locomotives

The first storage-battery electric mine locomotives were designated I-AR-113 (of 600-millimeter gauge) and 3-AR-113 (of 900-millimeter gauge). They were produced before 1939. In 1940, electric machine building plants began to put out a new series of storage-battery locomotives -- type II-AR (II -- weighing 8 tons, A -- storage battery, R -- mine). The II-AR is a modified form of the I-AR-113.

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Specifications of the II-AR-1 and II-AR-2 storage-battery electric mine locomotives are as follows:

	<u>II-AR-1</u>	<u>II-AR-2</u>
Gauge (mm)	550 - 600	750 - 900
Length (mm)	4,100	4,100
Width (mm)	1,044	1,344
Height, including battery box (mm)	1,480	1,300 1,480
Number of driving axles	2	2
Wheel base (mm)	1,100	1,100
Minimum turning circle, radius (m)	7	7
Wheel diameter (mm)	650	650
Gear ratio	6.92	6.92
Total weight, including battery (t)	8.0	8.5
Power, hourly rating (kw)	15.2	18.2
Specific power (kw/ton)	2.3	2.6
Tractive force, hourly rating (kg)	1,080	1,080
Traction coefficient	0.165	0.165
Speed, hourly rating (km/hr)	5.0	6.3
Tractive force, continuous rating (kg)	320	320
Speed, continuous rating (km/hr)	8.0	9.5
Number of traction motors	2	2
Type motors	DK-800A	DK-800A
Voltage	100	120
Amperage, hourly rating	100	100
Amperage, continuous rating	44	44
Type battery	EP-370/ EZhN-350	EP-370/ EZhN-350
Number of elements	50/80	60/96
Average discharge voltage	98	118
Battery capacity (a-hr)	370/350	370/350

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In accordance with GOST 5048-49, explosion-proof storage² battery mine locomotives will bear the designation ARV. Storage-battery mine locomotives for use in gas-free mines will bear the designation ARN. Thus, the II-AR-2 8-ton storage-battery locomotive will be designated the 8 ARV-900. The new standard also provides for the development of a powerful 12-ton storage battery mine locomotive, the 12 ARV-900.

[A photograph of the II-AR-1 locomotive appears on page 164.]

Combination Contact and Storage Battery Locomotives

Combination Contact and Storage Battery Locomotives are designed for hauling operations in mines where the presence of gas prohibits continuation of trolley lines. They can also be used in iron and copper mines where trolley lines are interrupted at certain places.

Design³ for a combination locomotive were worked out by the Giproglemash Institute, and the first experimental model was built at the Toretzkiy Machine Building Plant imeni Voroshilov. Modifications were carried out after the model was tested, and the plant began series production of the II-TAR-1m and the II-TAR-2m. In 1949 the production of these locomotives was temporarily stopped so that a method could be worked out for charging the storage batteries from the trolley line, since the necessity of charging batteries in a charging chamber greatly restricts the use of the locomotive.

The Aleksandrovskiy Machine Building Plant imeni Voroshilov has designed two combination locomotives; The II-TAR-4, and the II-TAR-5. These machines have an operators station at each end.

Many units and parts from the II-TR contact locomotives and II-AR storage battery locomotives went into the combination machines. The DK-800B traction motor used in the locomotives was rendered explosion proof, and was then designated the DK-800V.

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In conformity with GOST 5048-49, ~~contact storage-battery~~
locomotives will bear the designation AKR (A - storage battery,
K - contact, R - Mine).

Specifications:

	<u>II-TAR-1</u>	<u>II-TAR-2</u>	<u>II-TAR-4</u>	<u>II-TAR-5</u>
Gauge (mm)	550 - 600	900	580 - 600	900
Length (mm)	4,330	4,330	5,000	5,000
Width (mm)	1,000	1,288	1,007	1,307
Height from cab (mm)	1,600	1,600	1,600	1,600
Number of driving axles	2	2	2	2
Wheel base (mm)	1,100	1,100 1,100	1,350	1,350
Minimum turning circle, radius (m)	7	7	10	10
Wheel diameter (mm)	650	650	650	650
Gear ratio	6.92	6.92	6.92	6.92
Total weight (t)	7.3	7.9	8.0	8.75
Power, hourly rating (kw)	22.8/9.0	22.8/11.8	22.8/9.0	22.8/11.8
Specific power (kw/t)	3.12/1.23	2.90/1.49	2.85/1.12	2.63/1.35
Tractive force, hourly rating (kg)	980	980	980	980
Traction coefficient	0.13	0.12	0.12	0.12
Speed, hourly rating (km/hr)	8.3/3.4	8.3/4.32	8.3/3.4	8.3/4.32
Tractive force, continuous rating (kg)	350	350	350	350
Speed, continuous rating (km/hr)	12.5/5.75	12/6.9	12.5/5.75	12.0/6.9
Number of traction motors	2	2	2	2
Type motors	DK-800V	DK-800V	DK-800V	DK-800V
Voltage	250/120	250/144	250/120	250/144

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Amperage, hourly rating	55	55	55	55
Amperage, continuous rating	25	25	25	25
Type of battery	EP-250	EP-250	EP-250	EP-250
Number of elements in battery	60	72	60	72
Battery voltage	118	141	118	141
Battery capacity (ampere-hours)	250	250	250	250

[A photograph of the II-TAR-1m locomotive appears on page 196;
a drawing of the II-TAR-5 is on page 197.]

Smaller Electric Locomotives

Small electric mine locomotives are designed for car-spotting work in various parts of the mine.

In 1947, the Aleksandrovskiy Machine Building Plant began production of the modernized 1-TL-1m contact electric locomotive.

Specifications, 1-TL-1m:

Gauge (mm)	600
Length (mm)	2,660
Width (mm)	920
Height (mm)	1,400
Number of driving axles	2
Wheel base (mm)	792
Minimum turning circle, radius (m)	4
Wheel diameter (mm)	650
Gear ratio	6.92
Total weight (t)	3.2
Power, hourly rating (kw)	11.4

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Specific power (kw/t)	3.8
Tractive force, hourly rating (kg)	480
Traction coefficient	0.16
Speed, hourly rating (km/hr)	8.3
Tractive force, continuous rating (kg)	175
Speed, continuous rating (km/hr)	12.0
Number of traction motors	1
Type motor	DK-800B
Voltage	250
Amperage, hourly rating	55
Amperage, continuous rating	25

In accordance with GOST 5048-49, the 1-TL-1m will be designated the 3KR-600.

The AK-2 small storage-battery locomotive, designed by the Giprouglemash Institute in 1946, is now series-produced by the Kutaisi Gornyak Plant. Electric equipment for these locomotives is furnished by the Konotop Krasnyy Metallist Plant.

Specifications, AK-2:

Gauge (mm)	550, 575, 600
Length between couplings (mm)	1,905
Width (mm)	895
Height, from top of battery box (mm)	1,180
Wheel base (mm)	650
Wheel diameter (mm)	430
Total weight (t)	2
Number of driving axles	2
Number of traction motors	1

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Type motor	MT-1-V
Power, hourly rating (kw)	2.05; 2.15
Tractive force, hourly rating (kg)	160; 196
Traction coefficient	0.08; 0.1
Speed, hourly rating (km/hr)	4.35; 5.9
Amperage, hourly rating	97
Amperage, continuous rating	40
Type battery	EP-250
Number of elements	20
Battery voltage	40
Battery capacity (ampere-hours)	250
Maximum number of loaded, roller-bearing-equipped one-ton cars in train	5

✓Photo of AK-2 locomotive appears on page 201 of source document; drawing is on page 202.7

Shuttle Cars

The term "shuttle-car transport" is understood to mean a system of underground mining transportation from the face to the railroad tracks in self-propelled, self-unloading vehicles of considerable capacity, running on pneumatic tires.

The SKV-1.5 shuttle car put out by the Skopin Machine Building Plant has three electric motors: Two provide individual power to the rear wheels, and a third operates a scraper conveyer which unloads the coal. Power is supplied through a cable, reeled on a drum.

Specifications, SKV-1.5:

Capacity (cu m)	1.8
Weight (t)	3.0
Length (mm)	3,600

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Width (mm)	1,450
Height, to top of cable drum (mm)	1,340
Height, to top of body (mm)	1,150
Wheel base (mm)	1,700
Number of motors	3
Type motors	PN-45
Voltage	100
Power (kw)	4.2
Speed, loaded (km/hr)	3.6
Average speed of conveyer (m/sec)	0.15
Unloading time (min)	1.0
Cable drum capacity (m)	160
Minimum turning circle, external radius (m)	5.6

[A drawing of the SKV-1.5 faces page 208 of source document]

Industrial Electric Locomotives

Before 1941, Soviet plants put out the SO heavy industrial electric locomotive. The IV-KP-1A industrial electric locomotive which is now in production, can be coupled with another locomotive of the same model for heavy hauling. Both machines are mounted on two twin-axle trucks and receive power through pantograph collectors.

[Bulletin No 3, 1937, of the Moscow Dinamo Plant, describes the operation of the SO and its electrical equipment. The diagram of the electrical system of the IV-KP-1A locomotive facing page 226 of source document were worked out by the Moscow Dinamo Plant.]

Specifications:	<u>SO</u>	<u>IV-KP-1A</u>
Weight (kg)		
Rated	88,000	73,000
Ballast	6,000	7,000

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Total Weight	94,000	80,000
Voltage	750	1,500
Tractive force, hourly rating (kg)	18,600	13,800
Speed, hourly rating (km/hr)	19.6	21.0
Power, hourly rating (kw)	1,000	864
Traction coefficient	0.198	0.184
Maximum tractive force (kg)	23,500	20,000
Maximum speed (km/hr)	65	70
Traction motors		
Type	DPE-220A	DK-8A
Number	4	4
Hourly rating (kw)	250	216
Gear ratio	89:20 = 4.45	75:16 = 4.69
Ventilation	Forced	Forced
Gauge (mm)	1,524	1,524
Radius, minimum turning circle, with train (m)	60	60
Number of speeds	3	3 2
Type compressors	E-500	E-500
Number of compressors	2	2
Productivity of compressors, combined (liters/min) (liters/min)	3,500	3,500

[A drawing of the SO locomotive appears on page 230; drawing of the IV-KP-1A locomotive faces page 230.]

In the near future a series of KP (K- Contact; P- Industrial) electric locomotives will be produced. The series will comprise four sizes, and there will be maximum unification of parts and units, both mechanical and electrical. The specifications of the projected series is as follows:

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<u>Model</u>	<u>Rated</u>	<u>Weight (t):</u> <u>Total</u> <u>(with ballast)</u>	<u>No. of</u> <u>Motors</u>	<u>Motor</u> <u>Power,</u> <u>Hourly</u> <u>Rating(kw)</u>	<u>Gage(mm)</u>	<u>No. of</u> <u>Axles</u>
I-KP-3A	14	14	2	60	750	2
I-KP-4A	14	14	2	60	1,000	2
II-KP-2A	30	35	4	65	750	4
II-KP-3A	30	35	4	65	1,000	4
II-KP-4A	30	35	4	65	1,524	4
III-KP-1A	30	35	2	216	1,524	2
III-KP-2A	28	30	2	112	1,524	2
IV-KP-1A	Now in production. Specifications given in previous table.					
IV-KP-2A	73	80	4	216	1,524	4

The I-KP-3A and I-KP-4A locomotives are designed for hauling and spotting work at small surface [mining] enterprises. The II-KP-2A and II-KP-3A will be used at ferrous metallurgy, construction materials, and peat processing enterprises. The II-KP-4A is intended for hauling fuel at large electric power stations. The III-KP-1A and III-KP-2A locomotives are designed for intra-plant transportation. The IV-KP-1A is designed for use at open-pit coal and ferrous metallurgy enterprises. The IV-KP-2A is intended for use at metallurgical enterprises.

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